



Reconocimiento de Patrones

Version 2022-2

Bag of Words

[Capítulo 6]

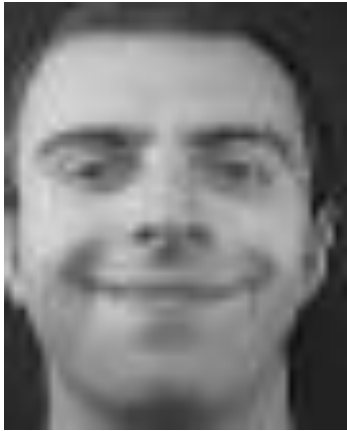
Dr. José Ramón Iglesias

DSP-ASIC BUILDER GROUP

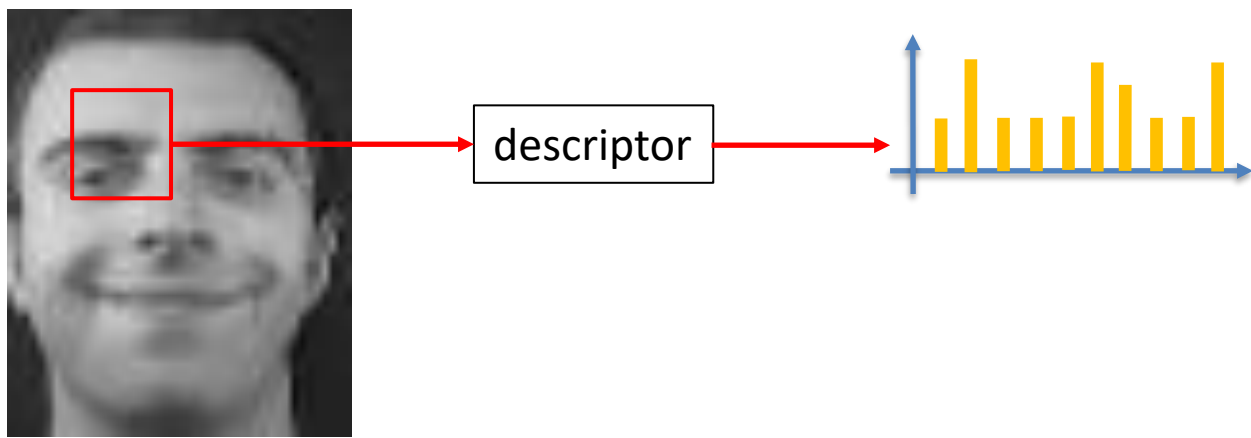
Director Semillero TRIAC

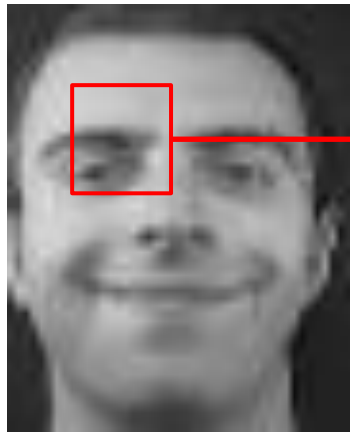
Ingeniería Electrónica

Universidad Popular del Cesar





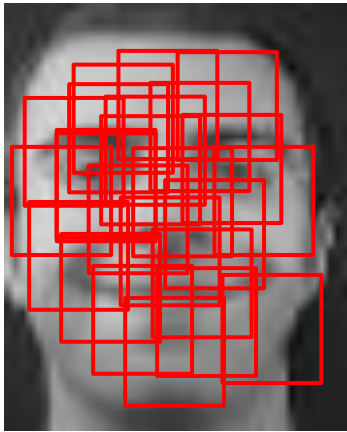




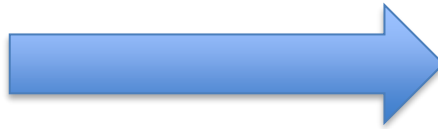
descriptor



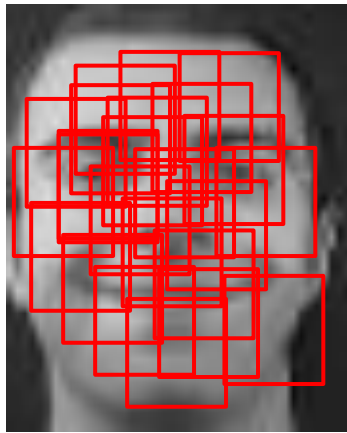
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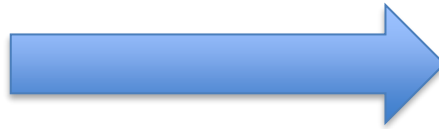
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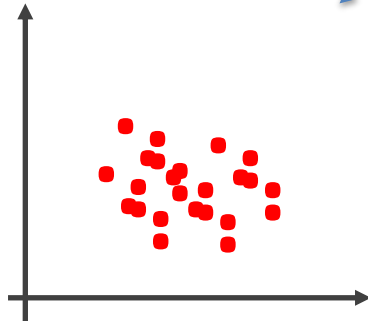
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description

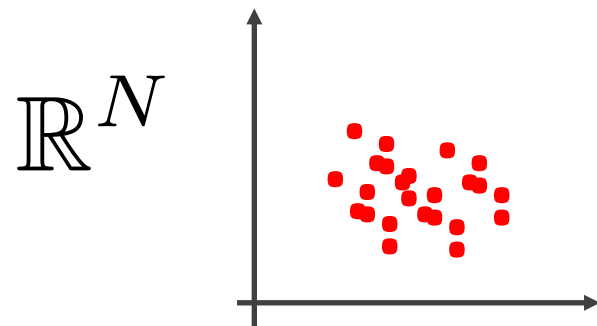
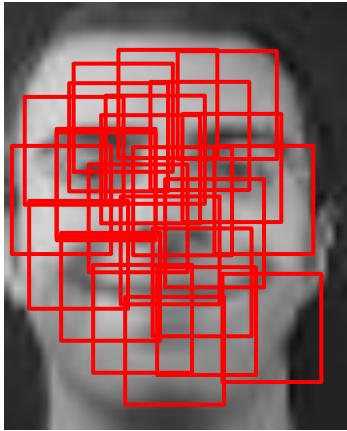


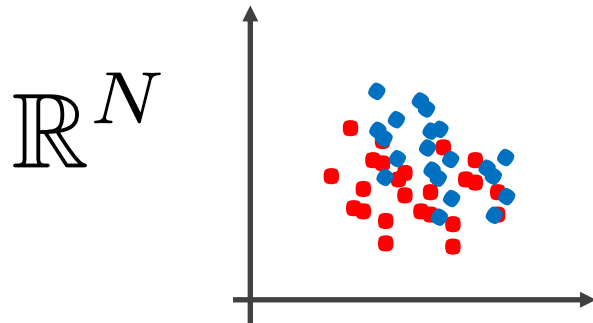
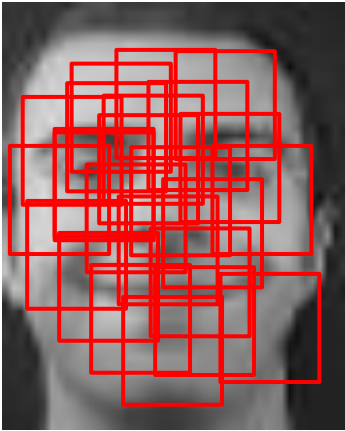
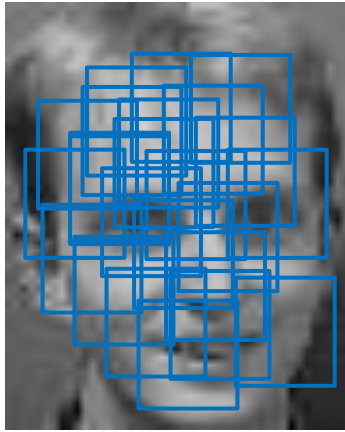
\mathbb{R}^N

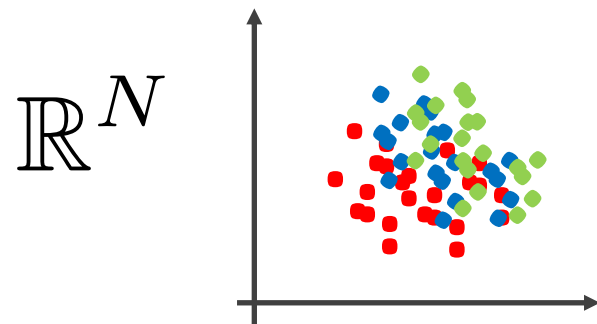
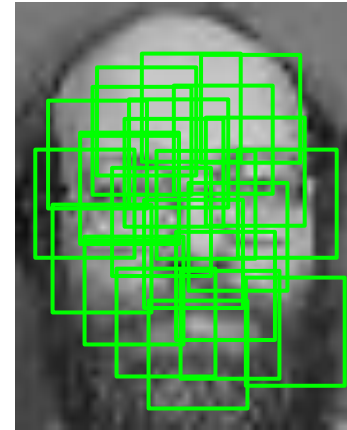
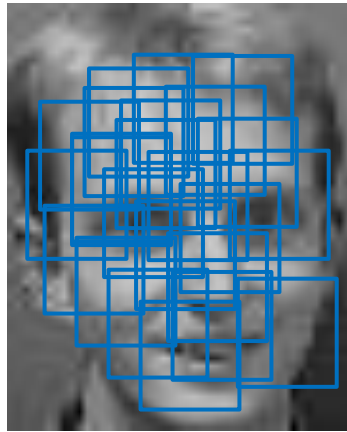
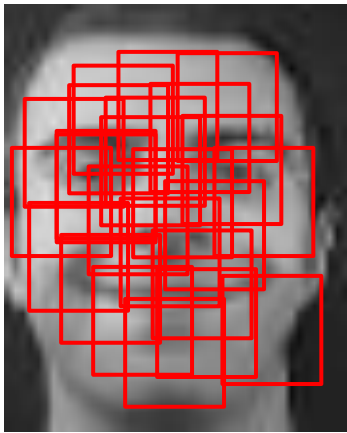


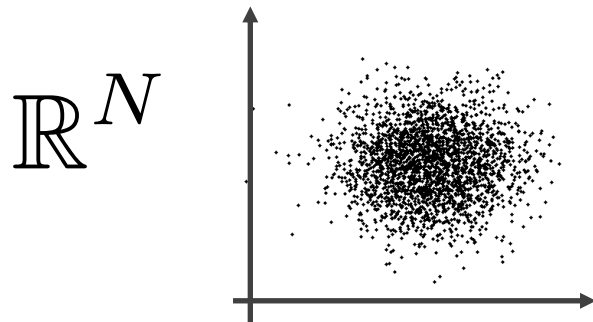
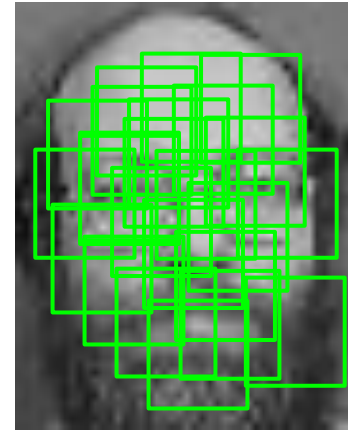
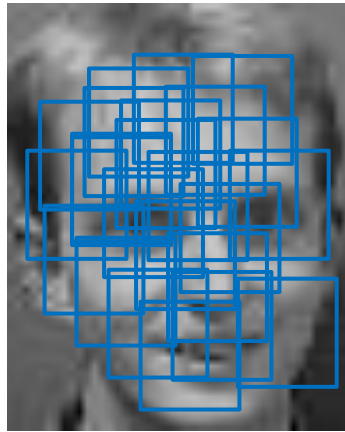
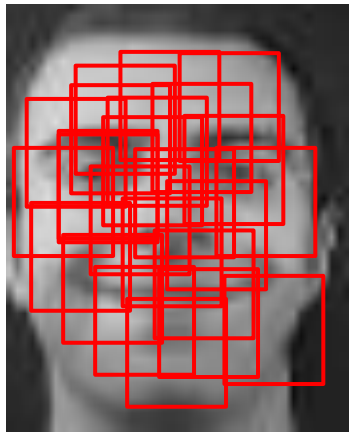
$\longleftrightarrow N \longrightarrow$

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12	12	3	10	12	12	3	10	12	17









$$\mathbb{R}^N$$

Description of
all parts



$$\mathbb{R}^N$$

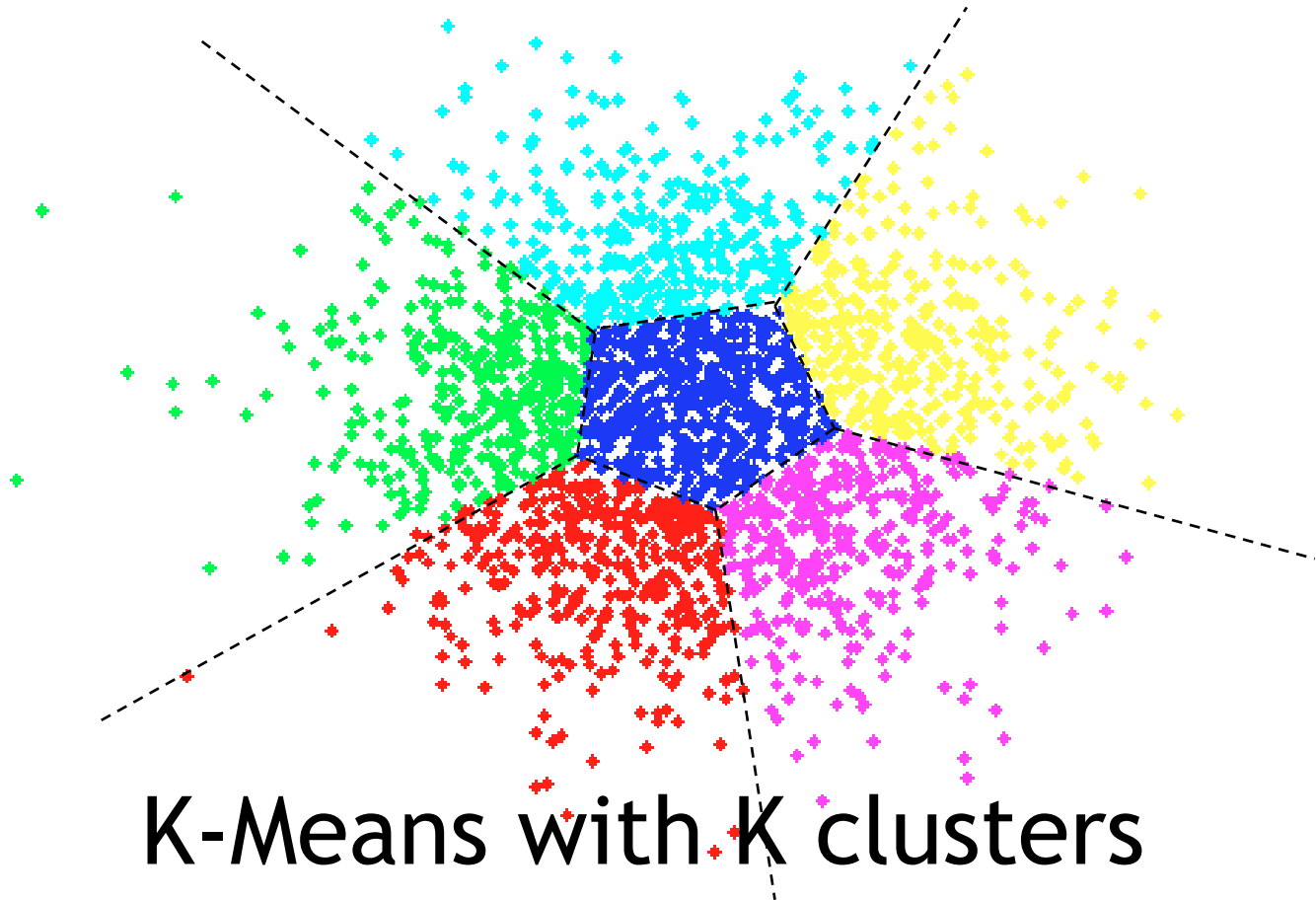
Description of
all parts



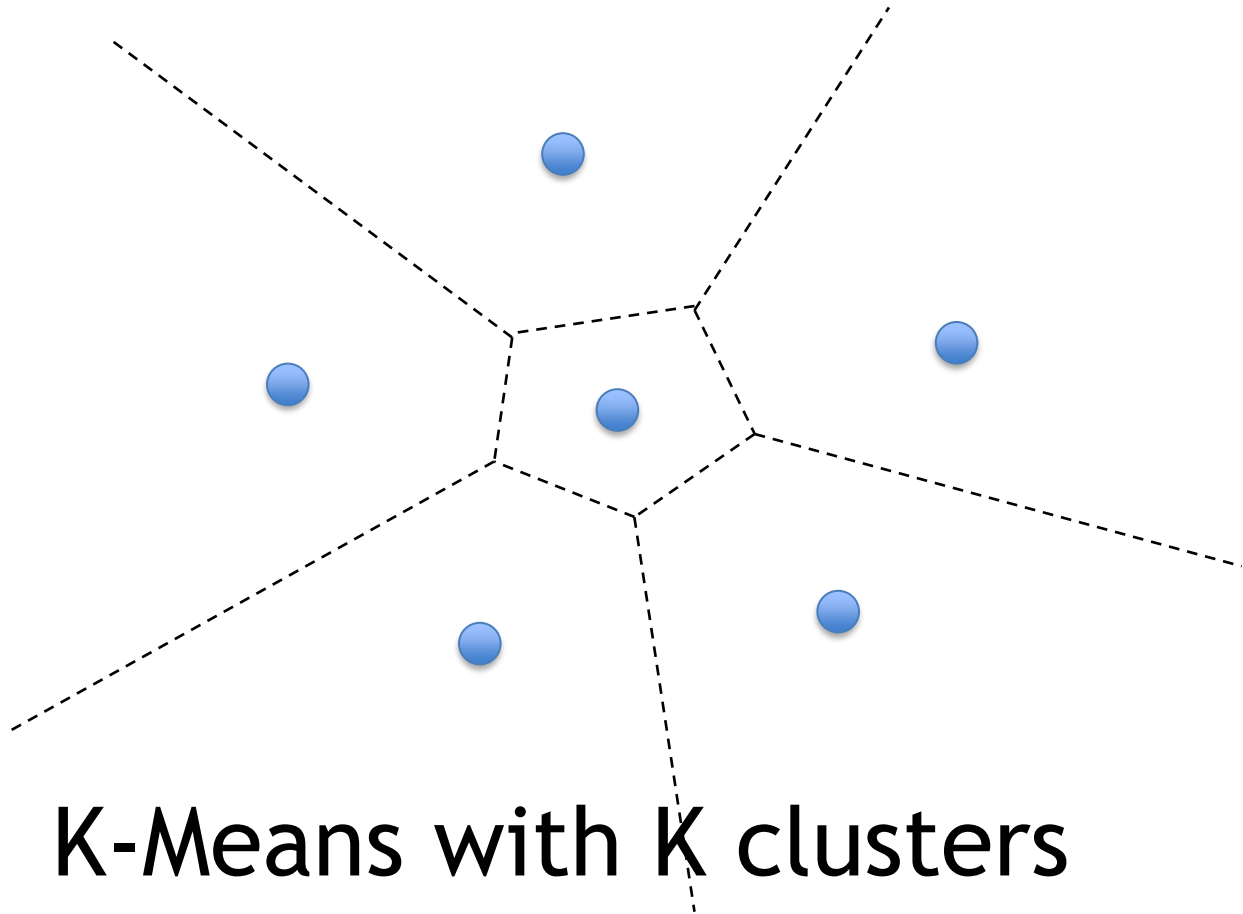
Description of
one part



Visual Vocabulary



Visual Vocabulary



K-Means with K clusters

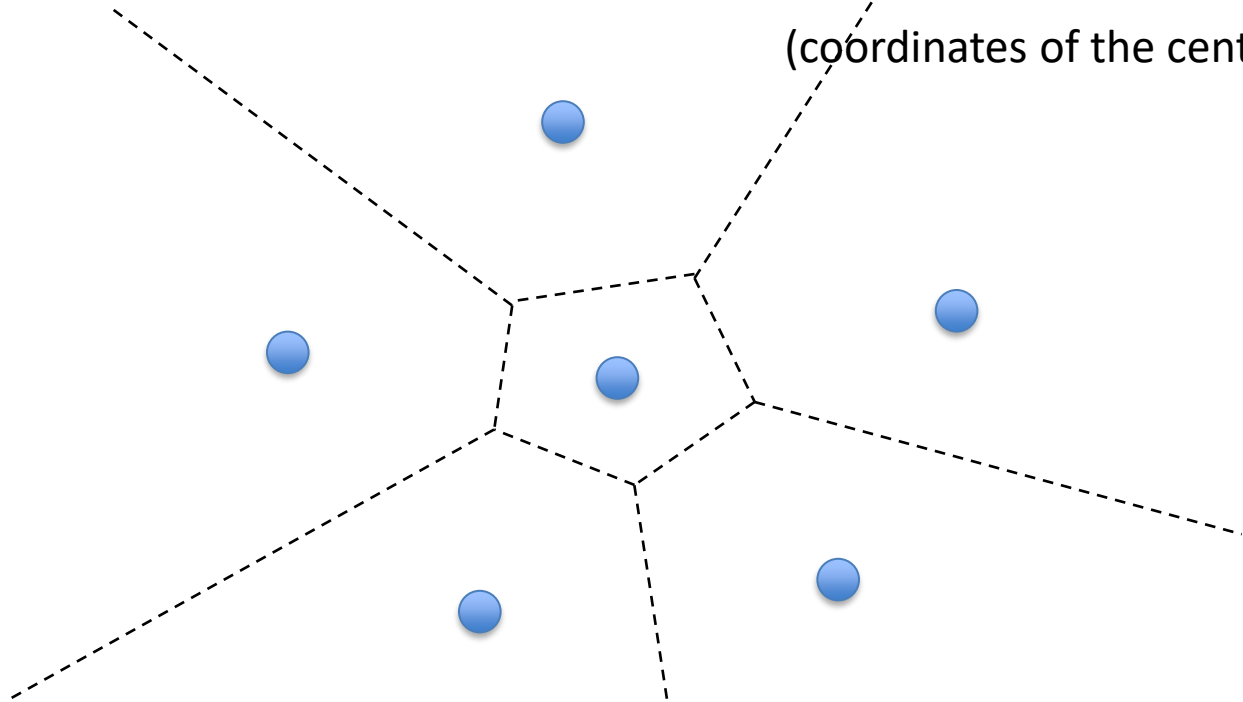
Visual Vocabulary

N

K

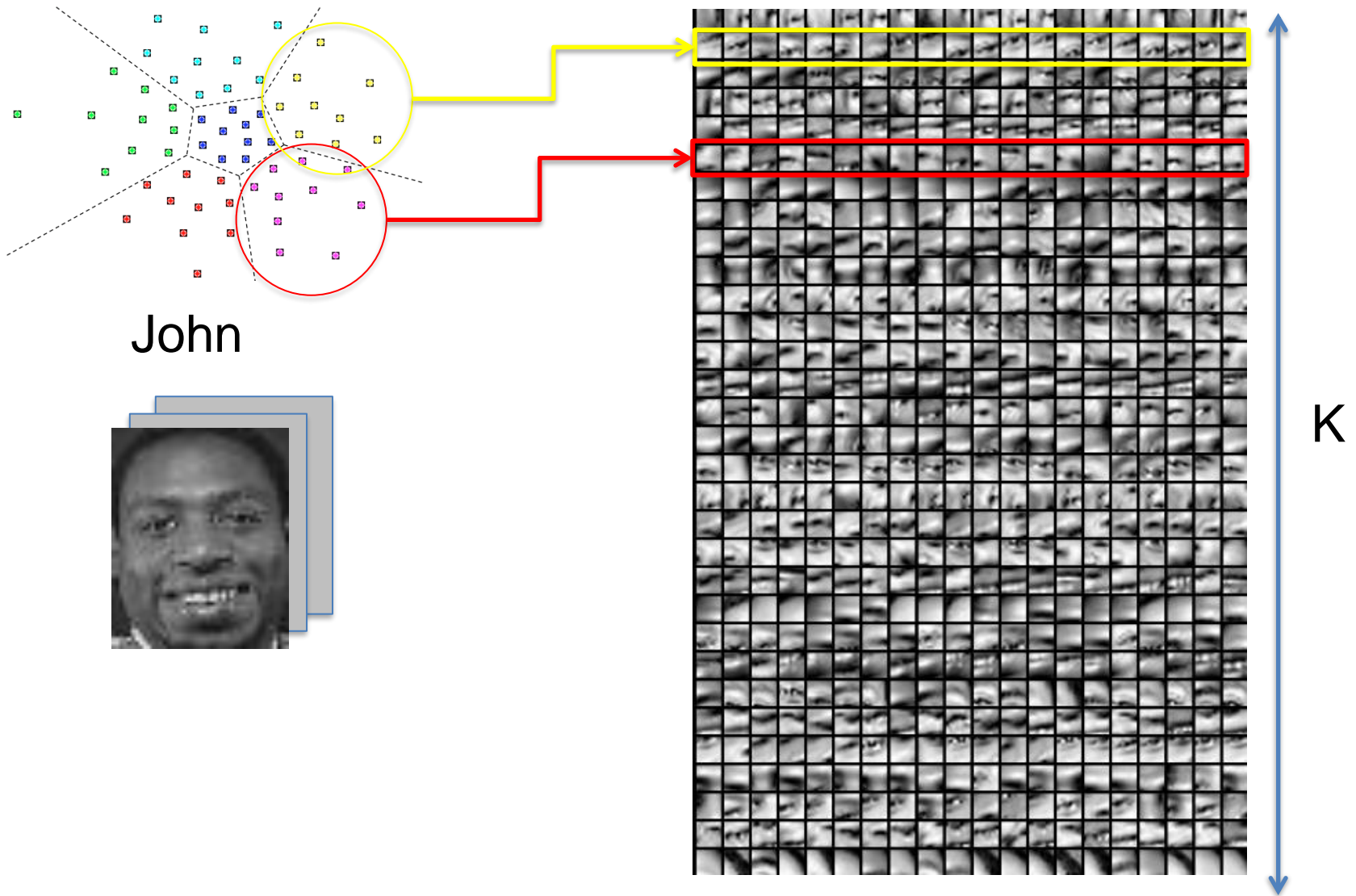
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12	29	11	10	12	10	12	34	12	14
3	10	12	34	12	10	12	34	12	14
12	12	3	10	12	12	3	10	12	15

(coordinates of the centroids)

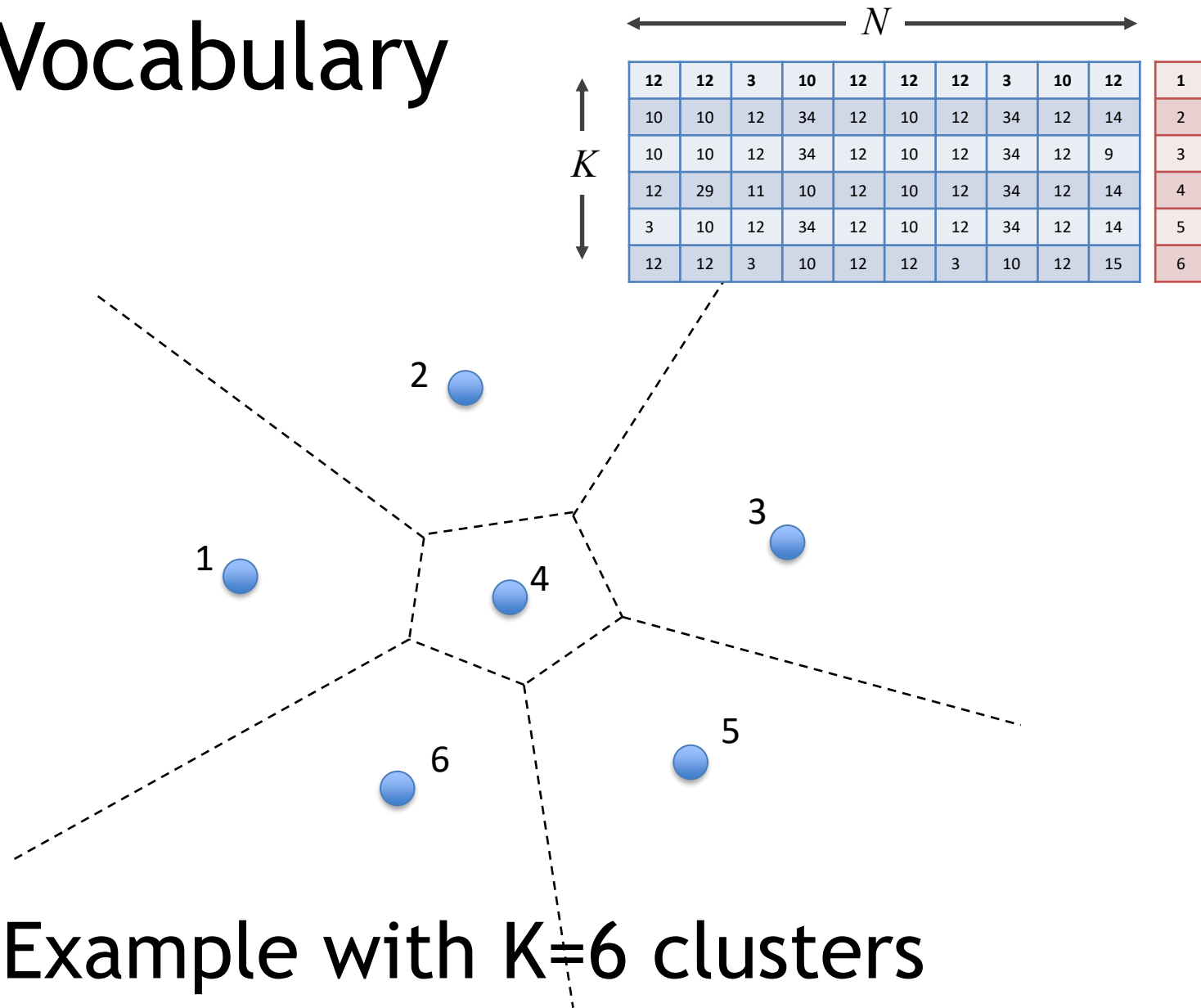


K-Means with K clusters

Example



Visual Vocabulary



Example with $K=6$ clusters



descriptor



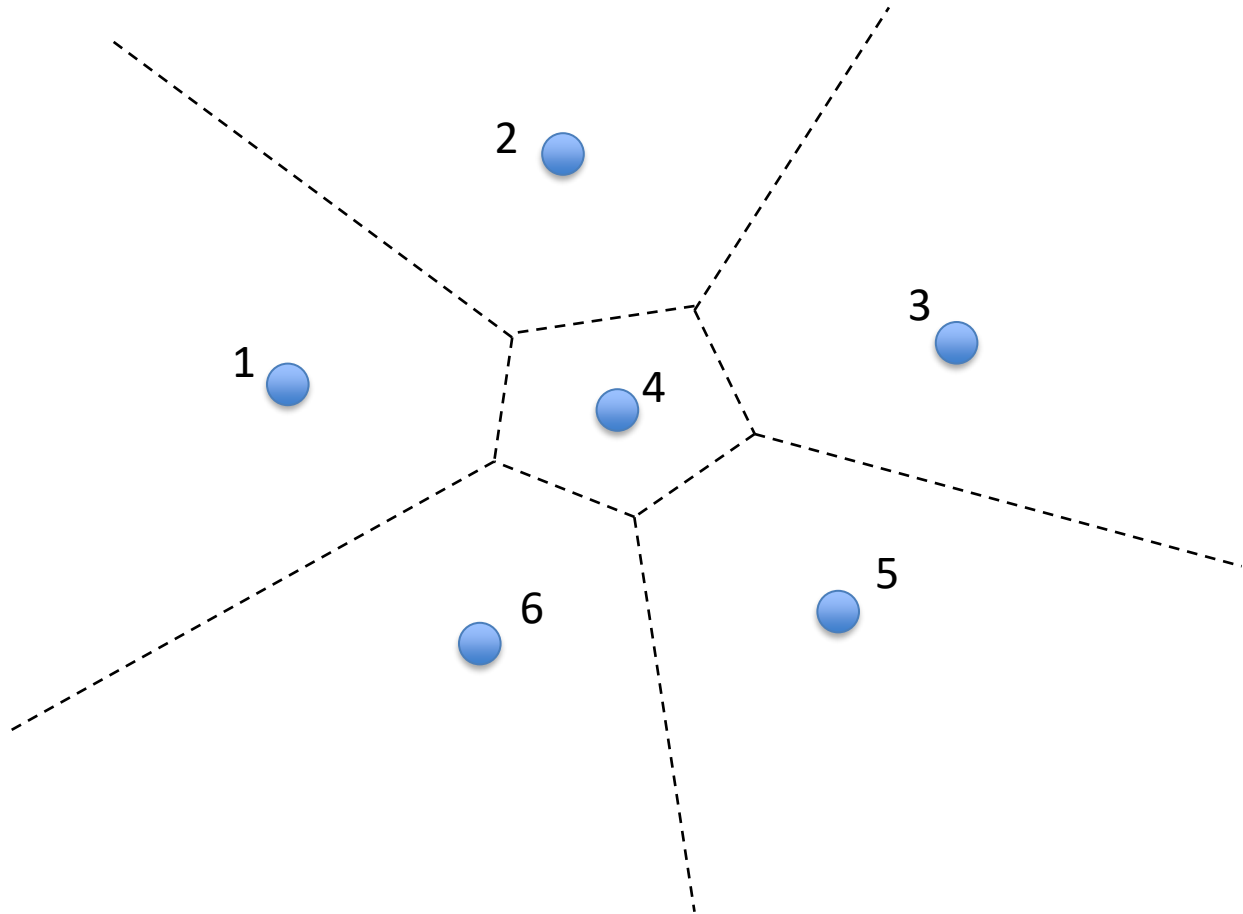
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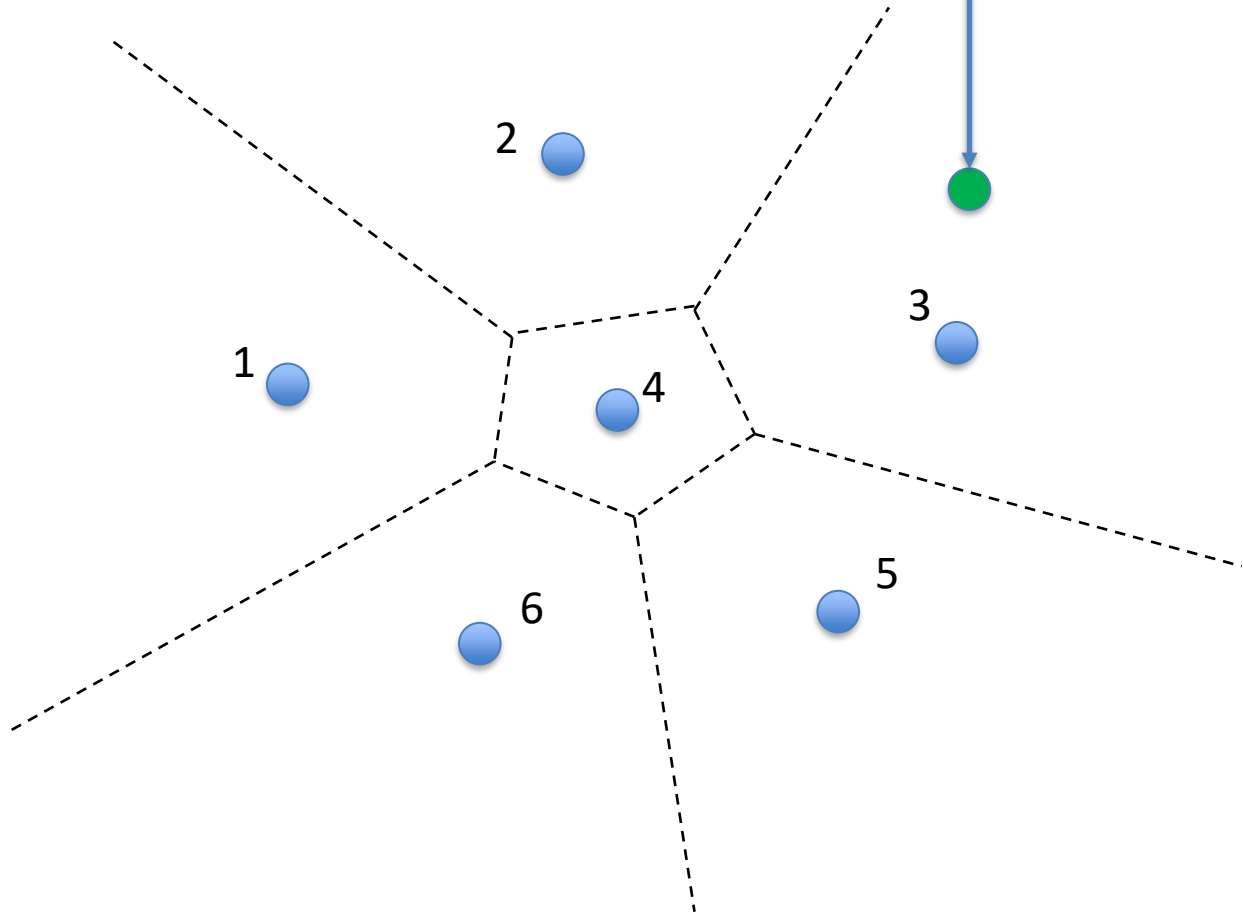


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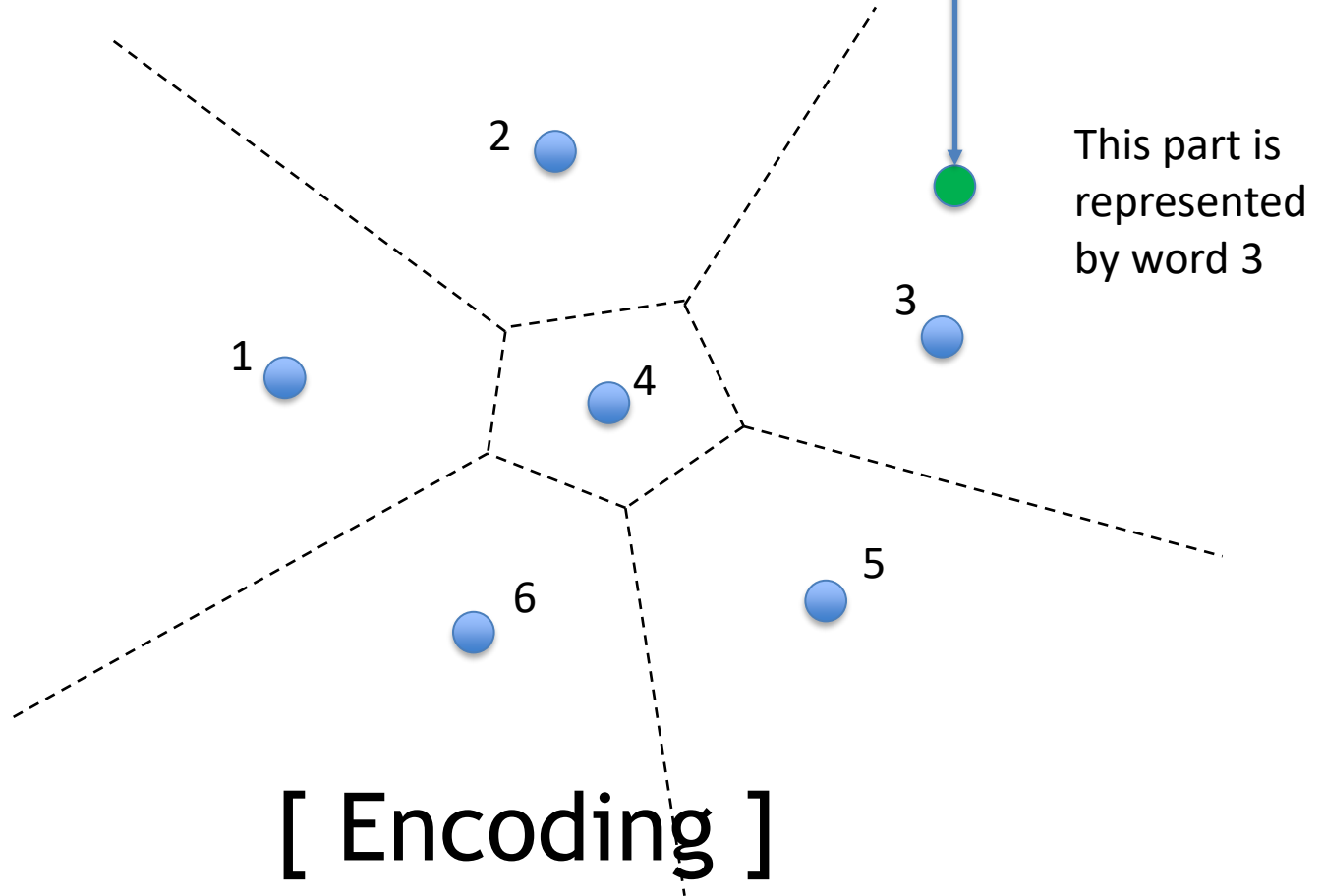


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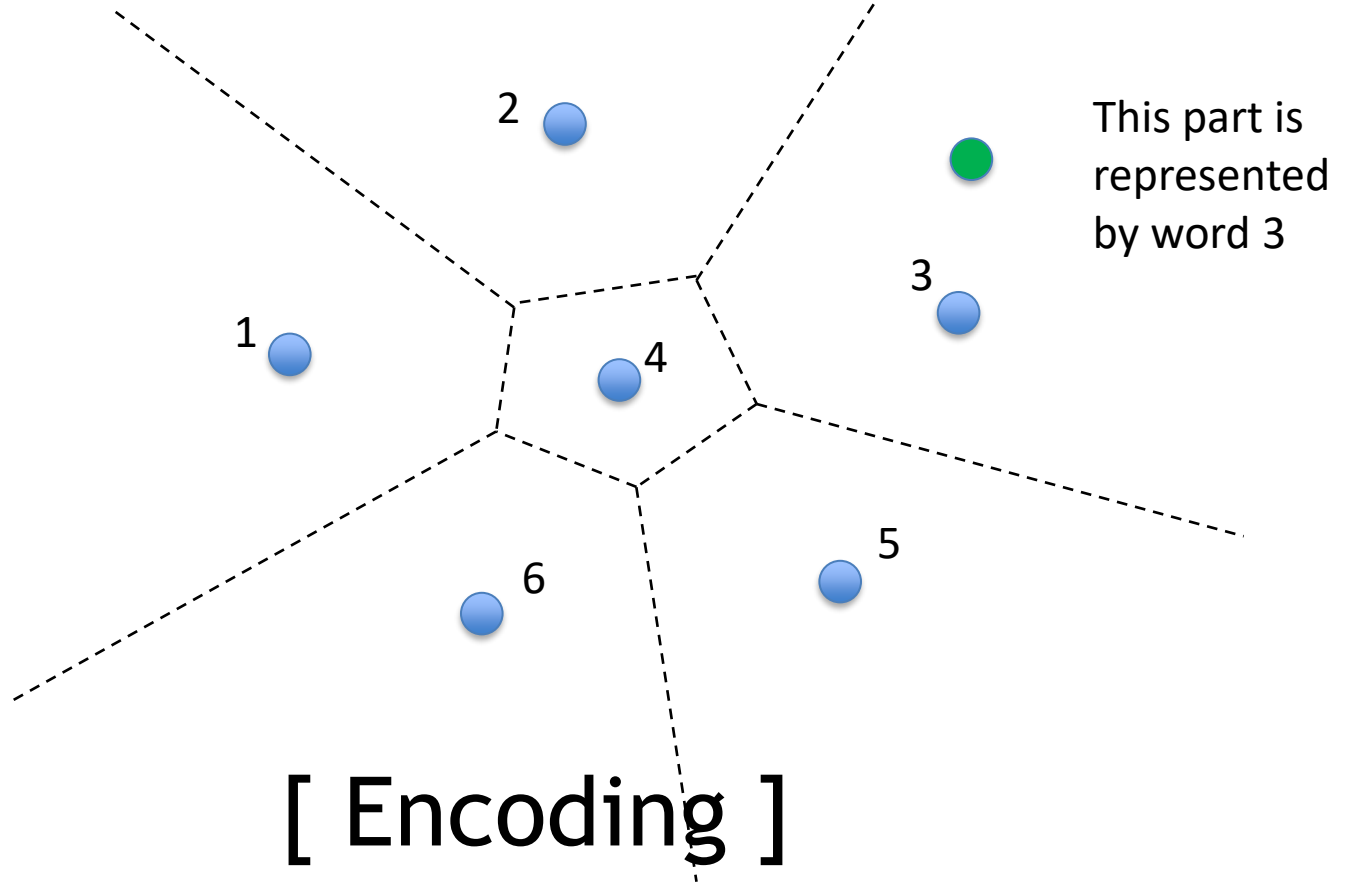
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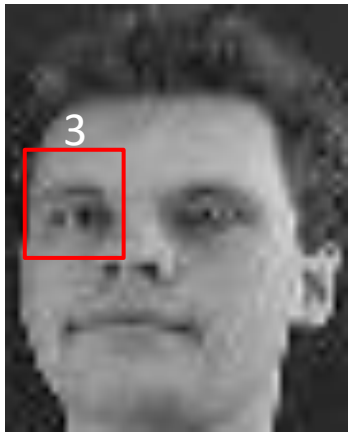




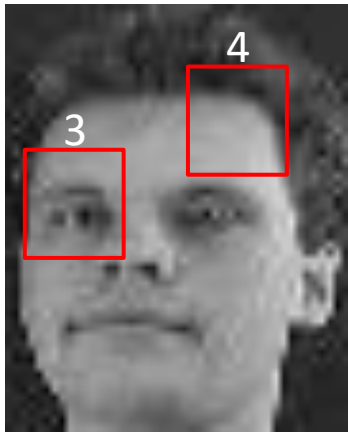
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12	29	11	10	12	10	12	34	12	14	4
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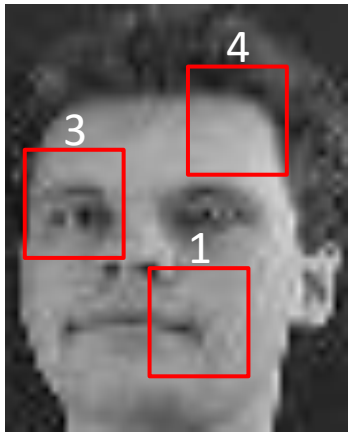




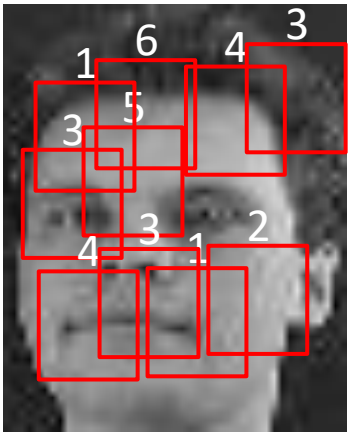
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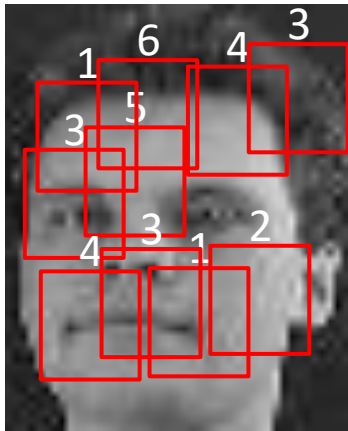
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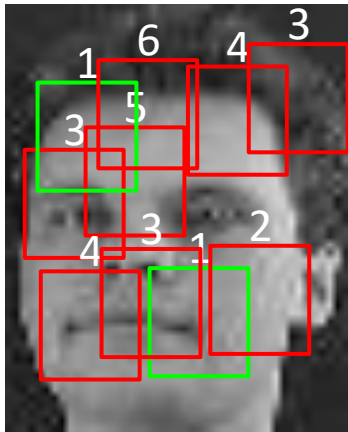
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[Encoding]

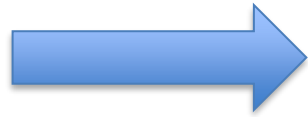
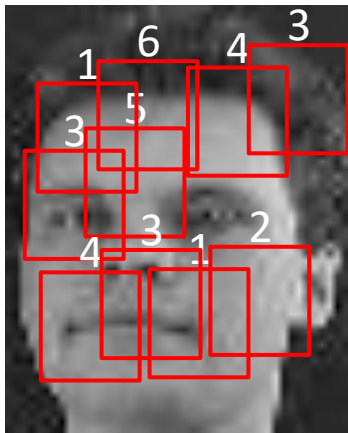


How many words '1' are in this image?

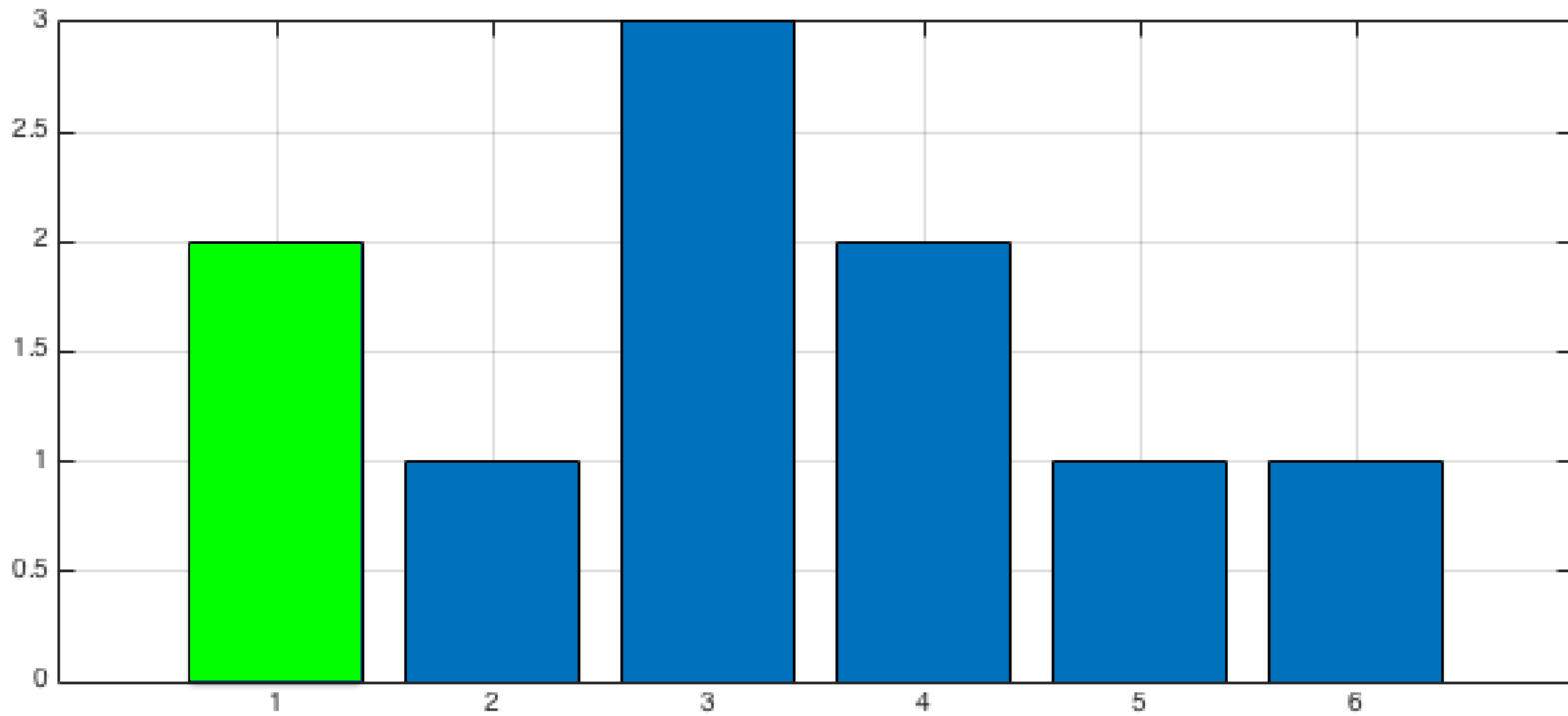


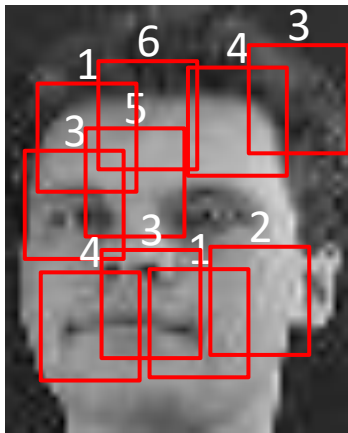
How many words '1' are in this image?

Answer: 2

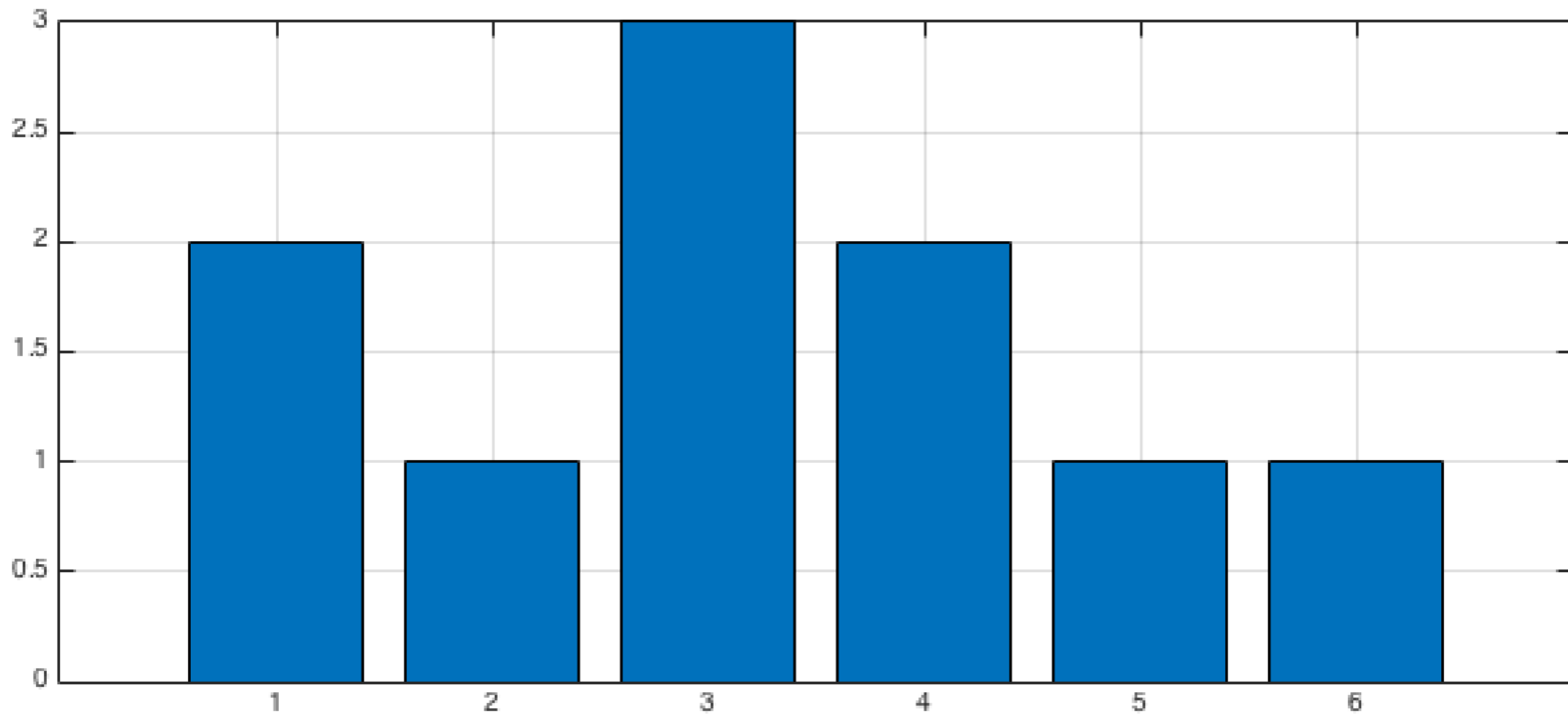


Histogram



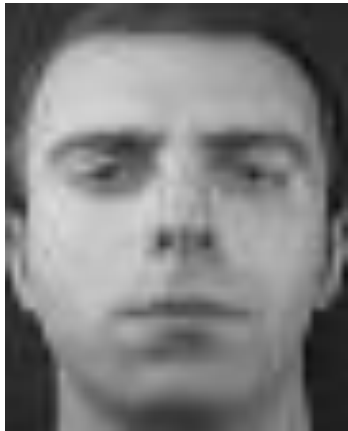
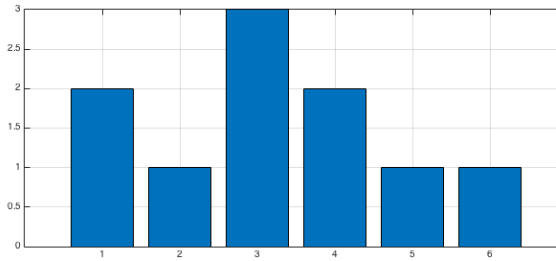
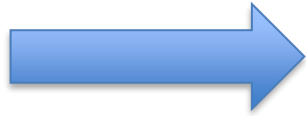


Histogram

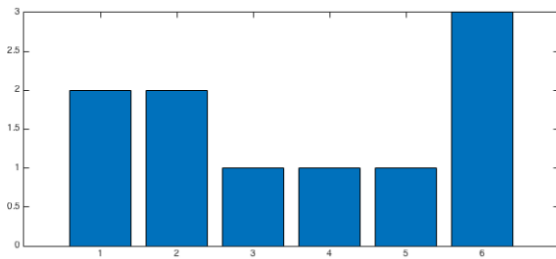
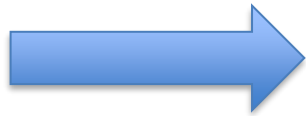




Histogram



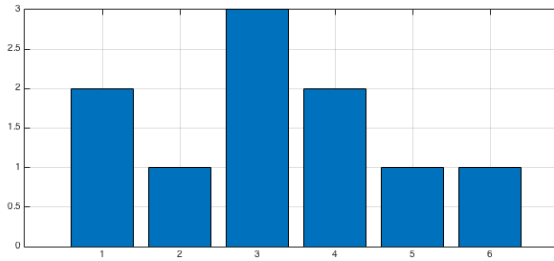
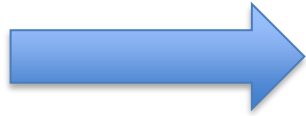
Histogram



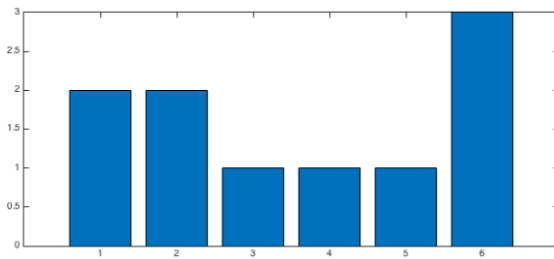
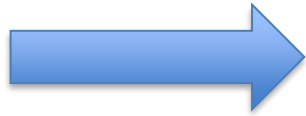
different
objects have
different
histograms



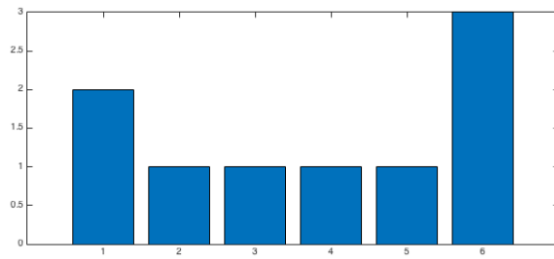
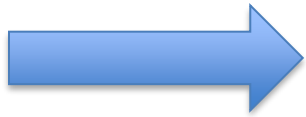
Histogram



Histogram



Histogram



same objects
have similar
histograms

Summary

PART 1: VISUAL VOCABULARY

1. Collect representative images
2. Extract descriptors (example LBP, HOG, SIFT, etc.)
3. K-means (Visual Vocabulary of K words)

Summary

PART 1: VISUAL VOCABULARY

1. Collect representative images
2. Extract descriptors
3. K-means (Visual Vocabulary of K words)

PART 2: CLASSIFIER DESIGN

1. For each image of the training set
 - Extract descriptors and encode them using the Visual Vocabulary
 - Build the histogram
2. Train a classifier using the new representation (histogram) of each image
3. Repeat for testing set and test the classifier

Ejemplo

Reconocimiento de Tigres (Biometría)



TRAINING

TRAINING



SIFT de cada una
de los Tigres

K-means de
todos los
SIFT

\mathcal{D}

12	12	3	10	12	12	12	3	10	12
10	10	12	34	12	10	12	34	12	14
10	10	12	34	12	10	12	34	12	9
12	29	11	10	12	10	12	34	12	14
3	10	12	34	12	10	12	34	12	14
12	12	3	10	12	12	3	10	12	15

TRAINING



SIFT de cada una
de los Tigres

K-means de
todos los
SIFT

\mathcal{D} Coordenadas de K centroides

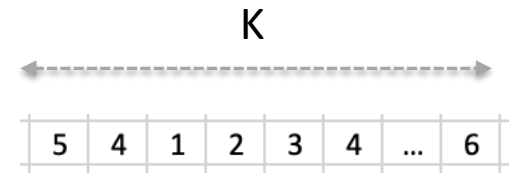
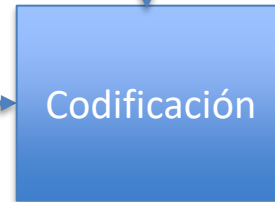
12	12	3	10	12	12	12	3	10	12
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12	29	11	10	12	10	12	34	12	14
3	10	12	34	12	10	12	34	12	14
12	12	3	10	12	12	3	10	12	15

↑
 K
↓
Diccionario de
K palabras
visuales

128

TRAINING

Para cada tigre del entrenamiento



\mathcal{D}

X

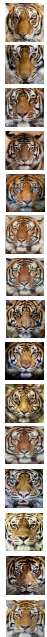
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4	1	4	3	2	1	...	4
3	2	3	2	1	2	...	3
2	3	2	1	2	3	...	2
1	4	1	2	3	4	...	1
2	5	2	3	4	5	...	2
3	6	3	4	5	6	...	3
4	5	4	5	6	5	...	4
5	6	5	6	5	6	...	5
6	7	6	5	6	7	...	6
5	8	5	6	7	8	...	5
6	9	6	7	8	9	...	6
7	0	7	8	9	0	...	7

y

1
1
1
2
2
2
2
3
3
3
4
4
4
5
5
5

Entrenar Clasificador

Clasificador Entrenado



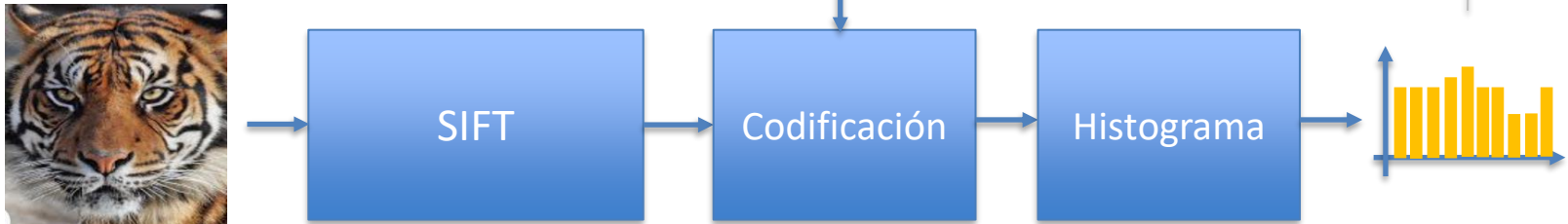
Histogramas

Labels

TESTING

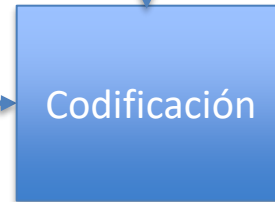
TESTING

Para el tigre de testing



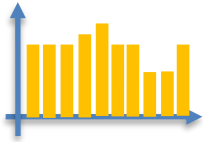
TESTING

Para el tigre de testing



\mathcal{D}

4	4	4	5	6	4	...	4
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Se puede usar este método para reconocer vacas?